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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, SESSION 2018/2019

EEL4126 – POWER SYSTEM OPERATION AND CONTROL (LE)

29 MAY 2019
9:00 AM – 11:00 AM
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question Paper consists of 3 pages including the cover page with FOUR Questions only.
2. Answer ALL questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided.

Question 1

- (a) List four constraints in Unit Commitment related problems in power system. [2 marks]
- (b) The following are data pertaining to three generators in a power plant.

Unit	Cost Characteristic (RM/Hr)	Max. Power (MW)	Min. Power (MW)
1	$C_1 = 5610 + 79.2P_1 + 0.01562P_1^2$	600	150
2	$C_2 = 3100 + 78.5P_2 + 0.0194P_2^2$	400	100
3	$C_3 = 936 + 95.64P_3 + 0.05784P_3^2$	200	50

Which unit or what is the combination of units should be used in order to supply a load of 550 MW most economically? [23 Marks]

[Hint: There will be 2^n possible combination, where n = number of generators in the plant.]

Question 2

- (a) Security constrained optimal power flow could be divided into FOUR categories. Name and explain each of them with aid of figures. [10 Marks]
- (b) Figure Q2 shows a 3-bus power system. The per unit (p.u.) values for the system is as shown in Table Q2. The system has the line reactances of $x_{12} = 0.2$ p.u., $x_{13} = 0.3$ p.u., and $x_{23} = 0.4$ p.u..

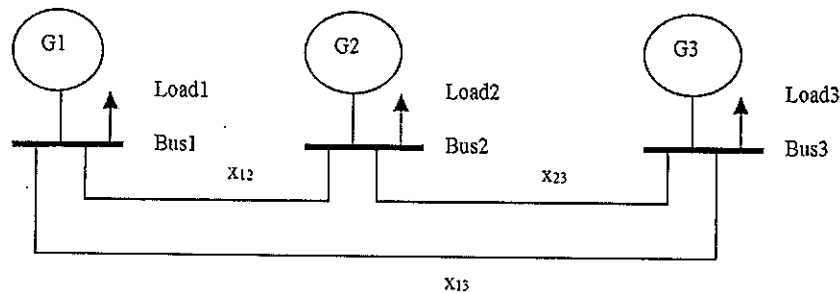


Figure Q2

Table Q2

Bus	Load (pu)	Gen. (pu)
1	1.2	1.5
2	2.8	1.8
3	1.0	1.7 (reference)

- (i) Find the [3x3] bus admittance matrix, B and hence determine the base power flows on the transmission lines. [9 Marks]
- (ii) Determine the generation shift factors for all lines for a change in Generator 1 (G1). [3 Marks]
- (iii) Compute the line outage distribution factor for line 2 – 3 for an outage of line 1 – 2 and the power flow in line 2-3 after the outage. [3 Marks]

Continued...

Question 3

- (a) Two generators G_1 and G_2 , with power rating of 200 MW and 400MW, respectively are supplying power to a network. Both the generators are loaded at 50% of their individual full rated capacity and operated at the system frequency of 50 Hz. What is the speed droop of generator G_1 and G_2 if the load on the system decreases by 150 MW and the frequency rises by 0.5 Hz? [5 Marks]
- (b) In power system network, tie-line is the transmission line that connecting two areas of the power system. The system is operating at 60 Hz. System capacity of Area 1 is 1000 MVA with speed drop, R_1 of 0.02 p.u and the load characteristic, D_1 equal to 1.0 p.u. ; whereas the system capacity for Area 2 is 500 MVA with the speed droop and load characteristic of $R_2 = 0.01$ p.u. and $D_2 = 0.8$ p.u., respectively.
- (i) Draw the block diagram of an interconnected two-area system where the tie flow was defined as going from area 1 to area 2. [8 Marks]
- (ii) If a sudden increase of 100 MW load occurs in Area 1, find the following:
- new steady state frequency,
 - change in tie-line power flow,
 - changes in prime mover powers, and hence
 - comment on the total change in generation.
- [12 Marks]

Question 4

- (a) With a neat sketch, explain the brushless excitation scheme for an alternator. [18 Marks]
- (b) The AVR system of an alternator has the following parameters.

	Amplifier	Exciter	Alternator	Sensor
Gain	9	1	1	1
Time constant	0.18	0.4	1.0	0.05

- (i) Draw the AVR block diagram. [3 Marks]
- (ii) Compute the closed loop transfer function. [3 Marks]
- (iii) Calculate the steady state error of the AVR for a step input. [1 Mark]

End of Paper.